Hall Meadow Brook

Connecticut

HALL MEADOW BROOK DAM DAM-BREAK FLOOD ANALYSIS

September 1986

US Army Corps of Engineers
New England Division

HALL MEADOW BROOK DAM

HOUSATONIC RIVER BASIN

CONNECTICUT

DAM-BREAK FLOOD ANALYSIS

FOR

DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

WALTHAM, MASSACHUSETTS

SEPTEMBER 1986

BY

VOLLMER ASSOCIATES
6 ST. JAMES AVENUE
BOSTON, MASSACHUSETTS 02116

HALL MEADOW BROOK DAM

DAM-BREAK ANALYSIS

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HALL MEADOW BROOK DAM

DAM-BREAK FLOOD ANALYSIS

1. INTRODUCTION

This report presents the findings of a dam-break flood analysis performed for Hall Meadow Brook Dam and Reservoir, an existing Corps of Engineers Flood Control Project, which is located upstream of Torrington, Connecticut. The dam is situated on Hall Meadow Brook approximately 0.4 mile upstream from the confluence with Hart Brook which forms the West Branch Naugatuck River. Included in this report is a description of the pertinent features of the dam, the procedure used for the analysis, the assumed dam-break conditions and resulting effects on downstream flooded areas, and the effects of varying conditions (sensitivity tests) on the resulting downstream flood. This study was not performed because of any known likelihood of a dam-break at Hall Meadow Brook Dam. Its purpose is to provide quantitative information for emergency planning use in accordance with Corps of Engineers Regulations (ER 1130-2-419).

2. PROCEDURE

The Hall Meadow Brook dam-break analysis was made using the "National Weather Service Dam-Break Flood Forecasting Computer Model", developed by D.L. Fread, Research Hydrologist, Office of Hydrology, National Weather Service, NOAA, Silver Spring, Maryland 20910. Input for the model consisted of: (a) storage characteristics of the reservoir, (b) selected geometry and duration of the breach development, (c) reservoir and downstream tributary inflows, and (d) hydraulic roughness coefficients. Based on the input data, the model computes the dam-break outflow hydrograph and routes it downstream. Dynamic unsteady flow routing is performed by a "honing" iterative process governed by the requirements of both the principles of conservation of mass and momentum. The analysis provides output on the attenuation of the flood hydrograph, resulting flood stages, and timing of the flood wave as it progresses downstream.

The approach used in this hypothetical dam-break analysis was first to apply the model using a selected set of conditions thought to be reasonably possible in a failure situation. The flood resulting from this analysis is termed the Base Flood Condition. For the Hall Meadow Brook Dam dam-break analysis the river valley was modeled in three reaches. The first reach is from Hall Meadow Brook Dam downstream to Stillwater Pond at mile 1.11 on the West Branch Naugatuck River. The second reach extends along the West Branch Naugatuck and Naugatuck Rivers to just upstream of Thomaston Reservoir at mile 10.79. The third reach consists of a flood routing analysis through Thomaston Reservoir. The outflow hydrograph of the first reach was used as the inflow hydrograph to the second reach. The same technique was applied for the third reach. Because any one of the major variables used in the model (initial pool elevation, antecedent riverflow, time of breach development, breach width, Manning's "n"), could in fact have different values occurring in different combinations from those used in the Base Flood determination, sensitivity analyses were employed to determine the effects that changed values of these parameters have upon the resulting flood wave.

The model was calibrated by comparing computed stage-discharge relationships with those high watermarks known to exist during the August 1955 flood at various locations along the river reach being modeled (i.e., at dams, bridges, stream flow gages, etc.).

3. DESCRIPTION OF STUDY AREA

a. General: The study area extends from Hall Meadow Brook Dam, downstream along the West Branch Naugatuck River through the community of Torrington to its confluence with the Naugatuck River and continues downstream to Thomaston Reservoir and Dam. Along the West Branch Naugatuck River, the study extends through the communities of Drakeville, Wrightville and West Torrington. The total length of the study area is approximately 16 miles. Along the study reach, the drainage area increases from 17.2 square miles at Hall Meadow Brook Dam to 97.2 square miles at Thomaston Dam. The purpose of Hall Meadow Brook Dam is to provide flood protection for the downstream valley and the community of Torrington. A map of the Housatonic River Basin is shown on Plate 1 including the location of Hall Meadow Brook Dam upstream from the community of Torrington.

b. Hall Meadow Brook Dam and Reservoir: Hall Meadow Brook Dam and Reservoir, completed in 1962, is located in northwestern Connecticut in the City of Torrington on Hall Meadow Brook approximately 0.4 mile upstream from its confluence with Hart Brook. The reservoir has a flood control storage capacity of 8620 acre-feet, equivalent to 9.4 inches of runoff from the 17.2 square mile drainage area. Major components consist of a rolled earth fill dam with rock slope protection, outlet works, a chute spillway, and a diversion channel from Rueben Hart Reservoir (see Plate 2). The dam consists of a rolled earth fill embankment section 1200 feet in length with rock slope protection and with a maximum height of 73 feet above streambed. The top of the dam is at elevation 917 feet NGVD, which provides for 14.1 feet of spillway surcharge and 4.9 feet of freeboard. The dam has a top width of 20 feet. The upstream slope is 1 vertical on 2.5 horizontal and downstream 1 vertical on 2 horizontal (see Plate 3). There is also a dike consisting of rolled earth fill embankment with rock slope protection approximately 135 feet long with a maximum height of 47 feet. Slopes are 1 on 2.5 upstream and downstream. The spillway is an uncontrolled ogee weir type, located adjacent to the right abutment of the dike. The weir is 100 feet long with a crest elevation of 898 feet NGVD. The outlet works are located on the right bank of the dam and consist of an inlet channel, inlet structure, a conduit and an outlet channel. The inlet structure contains a small concrete weir with stoplog openings and 3 x 4 foot manually operated sluice gate. The 48 inch RCP conduit is approximately 315 feet in length. Other pertinent data is listed in Table 1.

c. Downstream Valley: Hall Meadow Brook drops approximately 50 feet on its 0.4 mile course to Hart Brook, there forming the West Branch Naugatuck River. The West Branch Naugatuck River averages approximately 30 to 40 feet in width and drops 255 feet in 5.9 miles to the confluence of the East Branch. The confluence of the East and West Branches is within the center of the City of Torrington, forming the Naugatuck River. The West Branch local protection project in the City of Torrington consists of a concrete floodwall on the right bank between the Prospect Street and Main Street bridges, minor channel excavation, and deepening and widening the channel downstream of the Main Street bridge. The channel adjacent to Fuessenich Park was deepened and widened, with floodwalls added to retain a design streamflow of 12,600 cfs. There is also a local protection project on the East Branch. The Naugatuck River averages approximately 100 to 150 in width between the City of Torrington and Thomaston Dam. There are 17 crossings over Hall Meadow Brook, West Branch and Naugatuck River within the study reach including one federal highway, six state highways and nine local roads. There are five dams in the study reach downstream from Hall Meadow Brook Dam. The two significant dams are Stillwater Pond Dam, approximately 2.7 miles downstream, and Thomaston Dam and Reservoir. Stillwater Pond Dam is a high hazard dam as classified under the National Dam Inspection Program - U.S. Army Corps of Engineers.

The dam is 35 ft. high and 440 ft. long. It is an earth embankment with concrete corewall and concrete spillway. Thomaston Dam, located approximately 15.5 miles downstream of Hall Meadow Brook Dam, is a U.S. Army Corps of Engineers flood control dam. It is a rolled earth and rockfill dam 2000 feet in length, with a maximum height above streambed of 142 feet. The dam provides for a total storage capacity of 42,000 acre-feet, equivalent to 8.1 inches of runoff from the drainage area of 97.2 square miles.

TABLE 1

PERTINENT DATA

HALL MEADOW BROOK DAM AND RESERVOIR

LOCATION	Hall Meadow Brook, Torrington, CT
DRAINAGE AREA	17.2 square miles

RESERVOIR

	Conservation Pool	Flood Control Pool	Total at Spillway Crest
Full Pool Elevation (ft, NGVD)	860.0	898.0	898.0
Capacity (acre-feet)	318	8,620	8,620
(inches)	0.35	9.4	9.4
Full Pool Area (acres)	58	372	372

EMBANKMENT FEATURES

	Main Dam	Dike
Type	Rolled earth fill with rock slope protection	Rolled earth fill with rock slope protection
Length (feet)	1,200	1350
Top Elevation (feet NGVD)	917.0	917.0
Maximum Height (feet)	73	47
Top Width (feet)	20	12
Slopes upstream	1 on 2.5	1 on 2.5
downstream	1 on 2.0	

SPILLWAY FEATURES

Type	Chute spillway, ogee weir
Crest Length (ft)	100
Crest Elevation (ft, NGVD)	898.0

SPILLWAY DESIGN FLOOD

Peak Inflow (cfs)	26,600
Peak Outflow (cfs)	19,200
Maximum Surcharge (ft. above crest)	14.1

OUTLET WORKS

Type	Circular conduit
Size of Conduit	4' diameter
Length of Conduit (ft)	315
Conduit Inlet Invert Elevation (ft, NGVD)	842.0
Number of Gates	None
Capacity Discharge of Outlet, Reservoir at Spillway Crest (cfs)	455
Downstream Channel Capacity (cfs)	500

4. ASSUMED DAM-BREAK CONDITIONS

a. General: The magnitude of a flood resulting from the hypothetical failure of Hall Meadow Brook Dam is a function of many different parameters including size of breach, initial pool level and storage, rate of breach formation, channel and overbank roughness, and antecedent flow conditions. Engineering assumptions of conditions which could be reasonably expected to exist prior to a failure of Hall Meadow Brook Dam were used in the base flood analysis as presented below:

(1) Initial Pool Level - Hall Meadow Brook Dam: Water surface at spillway crest elevation 898 feet NGVD indicating 100% use of available flood control storage.

(2) Reservoir Inflow - Recession limb of August 1955 flood hydrograph (flood of record) riverflow, 800 cfs, following peak discharge during flood of 8,350 cfs (See Paragraph 4.a.(7)).

(3) Breach Invert - 840 feet NGVD.

(4) Breach Base Width - 175 feet, trapezoidal side slopes 1V: 1 H starting as piping failure.

(5) Time to Complete Formation of Breach- 1 hour.

(6) Downstream Channel Roughness - Manning's "n" = .045 to .16.

(7) Pre-Breach Flow - Hall Meadow Brook: A constant discharge of 800 cfs from Hall Meadow Brook Dam was utilized in this study. This discharge was needed for computational stability in the initial steady flow backwater computation in the computer model. Although the maximum outlet works capacity with pool at spillway crest is 455 cfs, the initial 800 cfs discharge used in the computer analysis has no effect on the resulting dam break analysis flood levels.

b. Selected Base Flood: Antecedent flow conditions on Hall Meadow Brook, West Branch Naugatuck and the Naugatuck River were selected to equal the recurring August 1955 record flood flows as modified by the Corps of Engineers East Branch and Hall Meadow Brook flood control reservoirs. Specifically, model input data for inflow into Hall Meadow Brook Reservoir consisted of the recessional side of the August 1955 flood hydrograph. The hydrograph was obtained from the U.S. Army Corps of Engineers, Master Manual of Water Control Regulation, June 1964, Revised October 1976. This was then routed through the reservoir assuming the pool was already filled to spillway crest level during the rising side of the same hydrograph. The inflow rate just prior to the beginning of failure was equal to 800 cfs and outflow from Hall Meadow Brook Dam was assumed to be a constant 800 cfs (See Paragraph 4.a.(7)). Peak inflows to the study reach below Hall Meadow Brook Dam include 1650 cfs at Jakes Brook, 2000 cfs at Drakes Pond Brook, 4130 cfs at Nickel Mine Brook, 3100 cfs at the East Branch Naugatuck and 30820 cfs at Leadmine Brook. Thomaston Reservoir was also assumed to be filled to spillway crest prior to the dam breach of Hall Meadow Brook Dam. The adopted initial antecedent flows and the comparative experienced 1955 discharges, as applicable, are shown in Table 2.

TABLE 2

ANTECEDENT FLOOD FLOW CONDITIONS

	ADOPTED ANTECEDENT	EXPERIENCED AUGUST 1955
Hall Meadow Brook	800*	8350
At Rte 4-West Torrington-Naugatuck R.	8580	17,000
At Confluence East Branch Naugatuck	11,680	25,400
At Confluence Leadmine Brook	42,500	

* Flow adopted for computer model. Actual maximum release from reservoir equal to 455 cfs.

5. RESULTS

The resulting peak stage flood profile and the areal extent of inundation for the base flood conditions is shown on Plates 5 and 6. Timing of the peak stage and leading edge of the flood wave are also indicated on the plan and profile. Peak discharge throughout the study reach associated with the development of the peak stage profile along with discharge and stage hydrographs for four stations downstream from Hall Meadow Brook Dam are shown on Plate 7. The stations are located .02, 2.77, 6.02 and 15.57 miles downstream from the dam.

The peak dam-break discharge from Hall Meadow Brook Dam is approximately 125,650 cfs producing a rise of approximately 34.0 feet above the normal river depth at a point .02 miles downstream from the dam. At a distance of 2.77 miles downstream from Hall Meadow Brook Dam along the West Branch Naugatuck, the peak flow would attenuate to 81,720 cfs and the depth of flow on the West Branch Naugatuck would increase to approximately 41.0 feet above normal river stage.

In the vicinity of the confluence of the East and West Branches of the Naugatuck River approximately mile 6.02, the peak flow attenuates to 74,220 cfs. The associated rise in stage on the Naugatuck River is approximately 33.1 feet above normal stage. The community of Torrington would most likely experience severe damage due to flooding. At a distance of 15.57 miles downstream of the dam, just below Thomaston Reservoir, the peak flow is attenuated to 45,420 cfs with an associated rise above normal stage of 25.0 feet. The surcharge capacity of Thomaston Reservoir attentuates the peak dam failure flow by approximately 20% even though the pool was assumed to be at spillway crest,

elevation 494 feet NGVD, at the start of the dam breach at Hall Meadow Brook Dam.
The flood control storage capacity of Thomaston Reservoir is almost five times greater than Hall Meadow Brook Dam. Therefore, an emptying of Hall Meadow Brook Reservoir into Thomaston does not overtax its regulating capacity or its surcharge capacity. The study was terminated just beyond Thomaston Reservoir along the Naugatuck River.

6. SENSITIVITY TESTS

In addition to analysis under the assumed dam-break conditions, subsequent studies were made to determine the sensitivity of certain selected parameters on the resulting downstream flood. The following are the variables considered.

a. Breach Width: The breach width was set at 175 feet for the base flood analysis. For sensitivity testing, two additional cases were analyzed with breach widths of 90 and 275 feet. As shown by comparative profile on Plate 8, the 75 foot breach width resulted in a flood stage 1.3 feet lower than the base flood at the dam, this difference reduced to less than 1 foot approximately 1 mile downstream of the dam. The 275 foot breach width had a flood stage 0.9 feet higher than the base flood at the dam. This difference reduced to less than 0.5 foot approximately 1 mile downstream of the dam.

b. Antecedent Flow: A sensitivity analysis was made assuming a low to moderate antecedent river flow equivalent to one-half the discharge of the recurring 1955 flood. The resulting comparative flood stage is shown on Plate 9. All discharges were reduced to one-half except for Jakes Brook which was held at 1000 cfs for computational stability. Within the first mile downstream from Hall Meadow Brook Dam, the antecedent flow has no effect on the dam breach peak stage. The low antecedent flow dam-break stage is 1 to 2 feet lower than the base flood on the West Branch and Naugatuck River.

c. Duration of Dam-Break: Though the selected duration for the failure time was one hour, runs were also made for failure times of both 3 and 5 hours. Changes in failure time resulted in major stage reduction of seven to thirteen feet in the upper portions of the study reach and diminished to one to four feet in the lower reaches. The relative effects of the three failure times on downstream flood profiles are illustrated on Plate 10.

d. Initial Pool Level: While a full reservoir condition (spillway crest 898 feet NGVD, 8,620 acre-feet) was assumed for the base flood, a test of the sensitivity of the dam-break flood to initial pool level was made assuming a one-half full pool condition (elevation 883.5 feet N.G.V.D., 4310 acre-feet). The resulting flood levels were significantly less, 8-9 feet less immediately downstream from Hall Meadow Brook Dam, and averaging 4 to 8 feet for the whole study reach to Thomaston Reservoir. Comparative water surface profiles are shown on Plate 11.

e. Channel Roughness: Manning's "n" sensitivity tests were made to determine their effects on downstream flood attenuation, resulting stages and timing. Tests were made with the Manning's "n" 15 percent less and 15 percent greater than the base flood. Increasing the channel roughness resulted in slower progression downstream with a slightly higher stage. Plate 12 compares water surface profiles.

f. Downstream Dam Failure: There is one major dam, Stillwater Pond Dam on the West Branch Naugatuck River downstream from Hall Meadow Brook Dam. In the event of a major dam-break at Hall Meadow Brook Dam, under full pool conditions, this dam may be seriously damaged or fail. The base flood assumed the dam remained intact and operated properly. For purposes of this test, Stillwater Pond Dam was assumed to fail at peak stage. The subsequent increase in stage is less than 1 foot for the failure. Plate 13 shows the comparative water surface profiles.

7. DISCUSSION

The dam-break analysis for Hall Meadow Brook Dam was based on the engineering application of certain laws of physics, considering the physical characteristics of the project and downstream channel, and conditions of failure. Due to the highly unpredictable nature of a dam-break and the ensuing sequence of events, the results of this study should not be viewed as exact but only as an approximate quantification of the dam-break flood potential. For purposes of analysis, downstream conditions are assumed to remain constant and no allowance is made for possible enlargement or relocation of the river channel due to scour or temporary damming effects, all of which could affect, to some extent, the resulting magnitude and timing of flooding downstream.

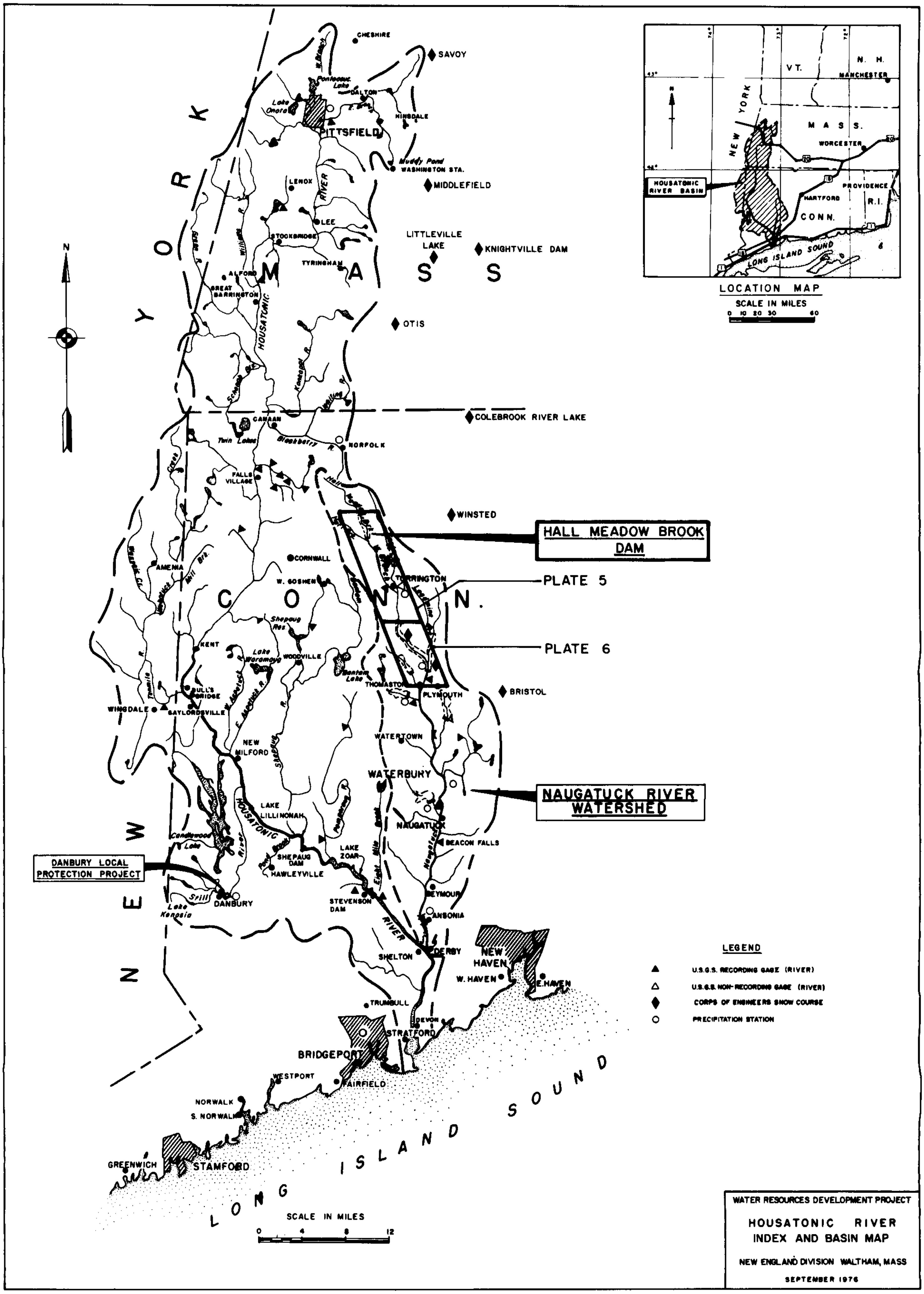
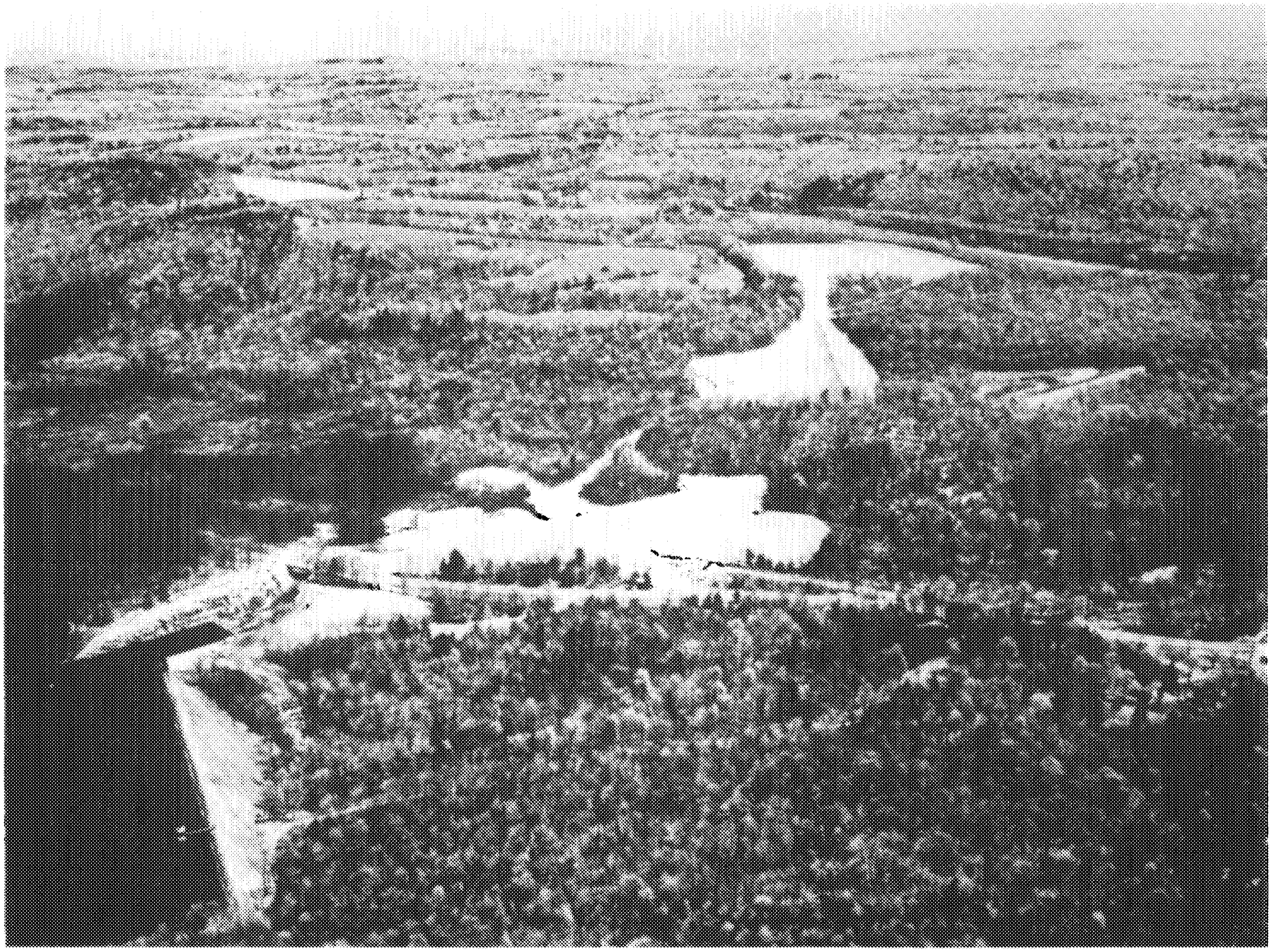

LOCATION MAP
SCALE IN MILES
VT.
N. H.
MANCHESTER
NEW YORK
MASS.
WORCESTER
HOUSATONIC RIVER BASIN
PROVIDENCE
HARTFORD
R.I.
CONN.
LONG ISLAND SOUND
CHESHIRE
SAVOY
DALTON
HINSDALE
PITTSFIELD
Lake Onota
Pontoosuc Lake
Muddy Pond
WASHINGTON STA.
MIDDLEFIELD
LENOX
LEE
STOCKBRIDGE
LITTLEVILLE LAKE
KNIGHTVILLE DAM
TYRINGHAM
ALFORD
GREAT BARRINGTON
M A S S
OTIS
HOUSATONIC
N E W Y O R K
COLEBROOK RIVER LAKE
CANAAN
Twin Lakes
Blackberry R.
NORFOLK
FALLS VILLAGE
WINSTED
HALL MEADOW BROOK DAM
CORNWALL
AMENIA
W. GOSHEN
TORRINGTON
PLATE 5
C O N N.
Shepaug Res.
PLATE 6
KENT
Lake Waramaug
WOODVILLE
Bantam Lake
THOMASTON
PLYMOUTH
BRISTOL
BULL'S BRIDGE
WINGDALE
SAYLORDSVILLE
NEW MILFORD
WATERTOWN
WATERBURY
NAUGATUCK RIVER WATERSHED
LAKE LILLINONAH
NAUGATUCK
BEACON FALLS
Candlewood Lake
DANBURY LOCAL PROTECTION PROJECT
SHEPAUG DAM
HAWLEYVILLE
LAKE ZOAR
STEVENSON DAM
DANBURY
Lake Kenosia
SEYMOUR
ANSONIA
RIVER
SHELTON
DERBY
NEW HAVEN
W. HAVEN
E. HAVEN
TRUMBULL
DEVON
STRATFORD
BRIDGEPORT
WESTPORT
FAIRFIELD
NORWALK
S. NORWALK
GREENWICH
STAMFORD
LONG ISLAND SOUND
SCALE IN MILES
0 4 8 12
LEGEND
U.S.G.S. RECORDING GAGE (RIVER)
U.S.G.S. NON-RECORDING GAGE (RIVER)
CORPS OF ENGINEERS SNOW COURSE
PRECIPITATION STATION
WATER RESOURCES DEVELOPMENT PROJECT
HOUSATONIC RIVER
INDEX AND BASIN MAP
NEW ENGLAND DIVISION WALTHAM, MASS
SEPTEMBER 1976

PLATE I

PLATE 2



View of Hall Meadow Brook Dam

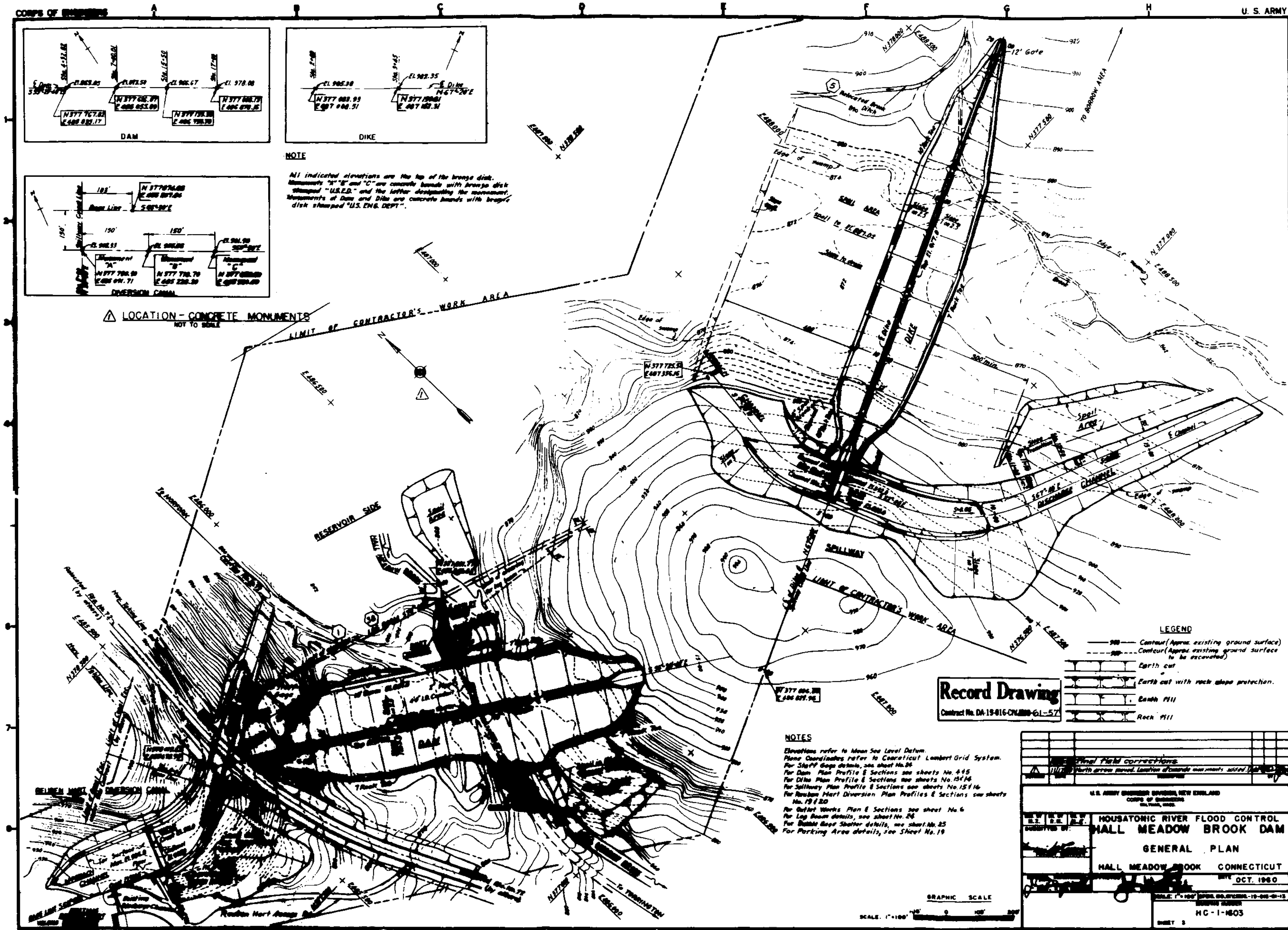

CORPS OF ENGINEERS
U. S. ARMY
DAM
DIKE
DIVERSION CANAL
LOCATION - CONCRETE MONUMENTS
NOT TO SCALE
NOTE
All indicated elevations are the top of the bronze disk. Monuments "A" "B" and "C" are concrete bounds with bronze disk stamped "U.S.E.D." and the latter designating the monument. Monuments at Dam and Dike are concrete bounds with bronze disk stamped "U.S. ENG. DEPT".
LIMIT OF CONTRACTOR'S WORK AREA
RESERVOIR SIDE
SPILLWAY
DIKE
DISCHARGE CHANNEL
Spoil Area
12' Gate
TO BORROW AREA
To TORRINGTON
LEGEND
Contour (Approx. existing ground surface)
Contour (Approx. existing ground surface to be excavated)
Earth cut
Earth cut with rock slope protection.
Earth fill
Rock fill
Record Drawing
Contract No. DA-19-016-CIVENG-61-57
NOTES
Elevations refer to Mean Sea Level Datum.
Plane Coordinates refer to Connecticut Lambert Grid System.
For Staff Gage details, see sheet No. 24
For Dam Plan Profile & Sections see sheets No. 4 & 5
For Dike Plan Profile & Sections see sheets No. 13 & 14
For Spillway Plan Profile & Sections see sheets No. 15 & 16
For Reuben Hart Diversion Plan Profiles & Sections see sheets No. 19 & 20
For Outlet Works Plan & Sections see sheet No. 6
For Log Boom details, see sheet No. 24
For Bubble Gage Shelter details, see sheet No. 25
For Parking Area details, see Sheet No. 19
GRAPHIC SCALE
SCALE: 1"=100'
Final field corrections
North arrow moved. Location of concrete monuments added.
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
HOUSATONIC RIVER FLOOD CONTROL
HALL MEADOW BROOK DAM
GENERAL PLAN
HALL MEADOW BROOK CONNECTICUT
OCT. 1960
HC-1-1603
SHEET 3

PLATE 3

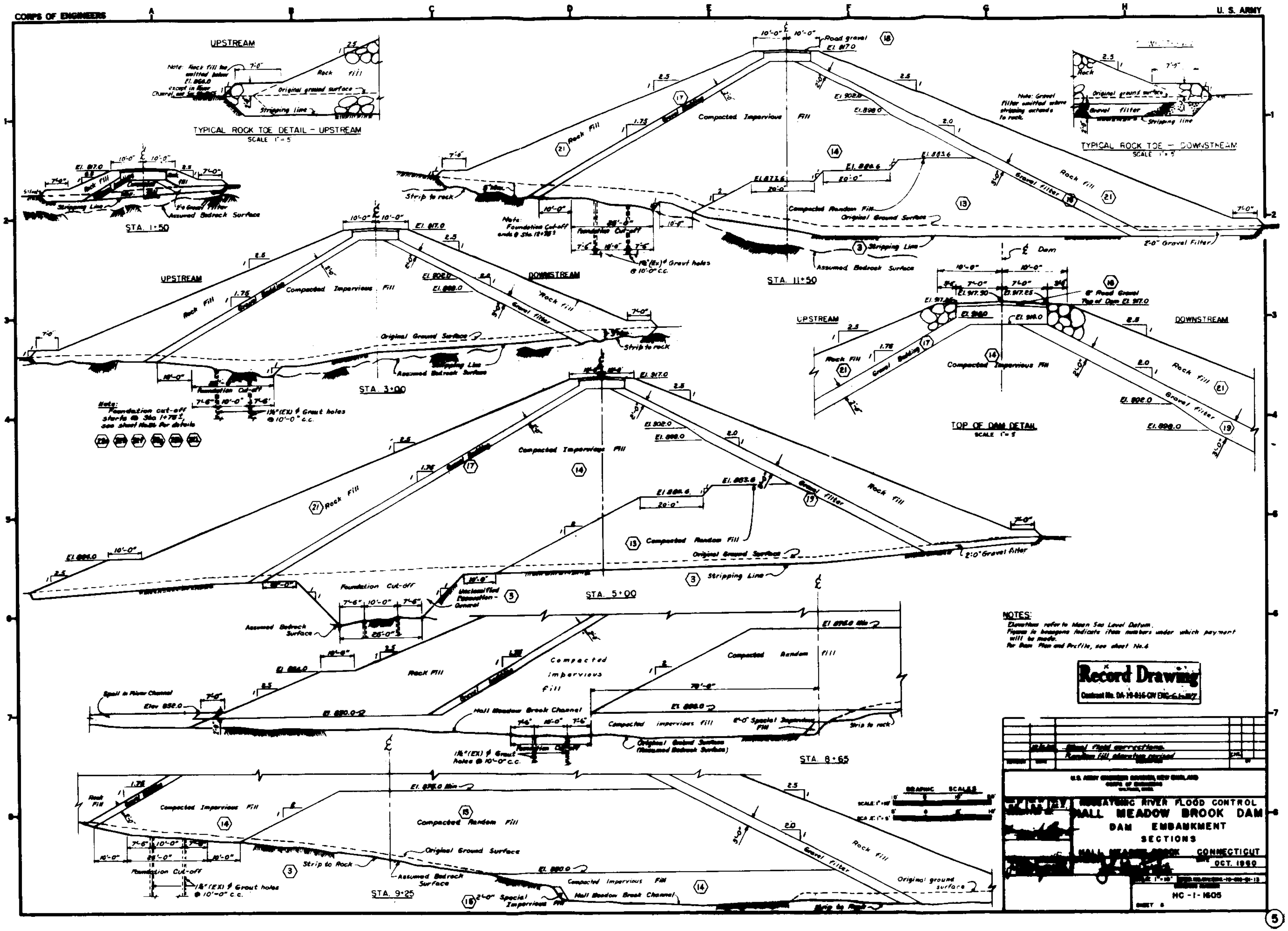
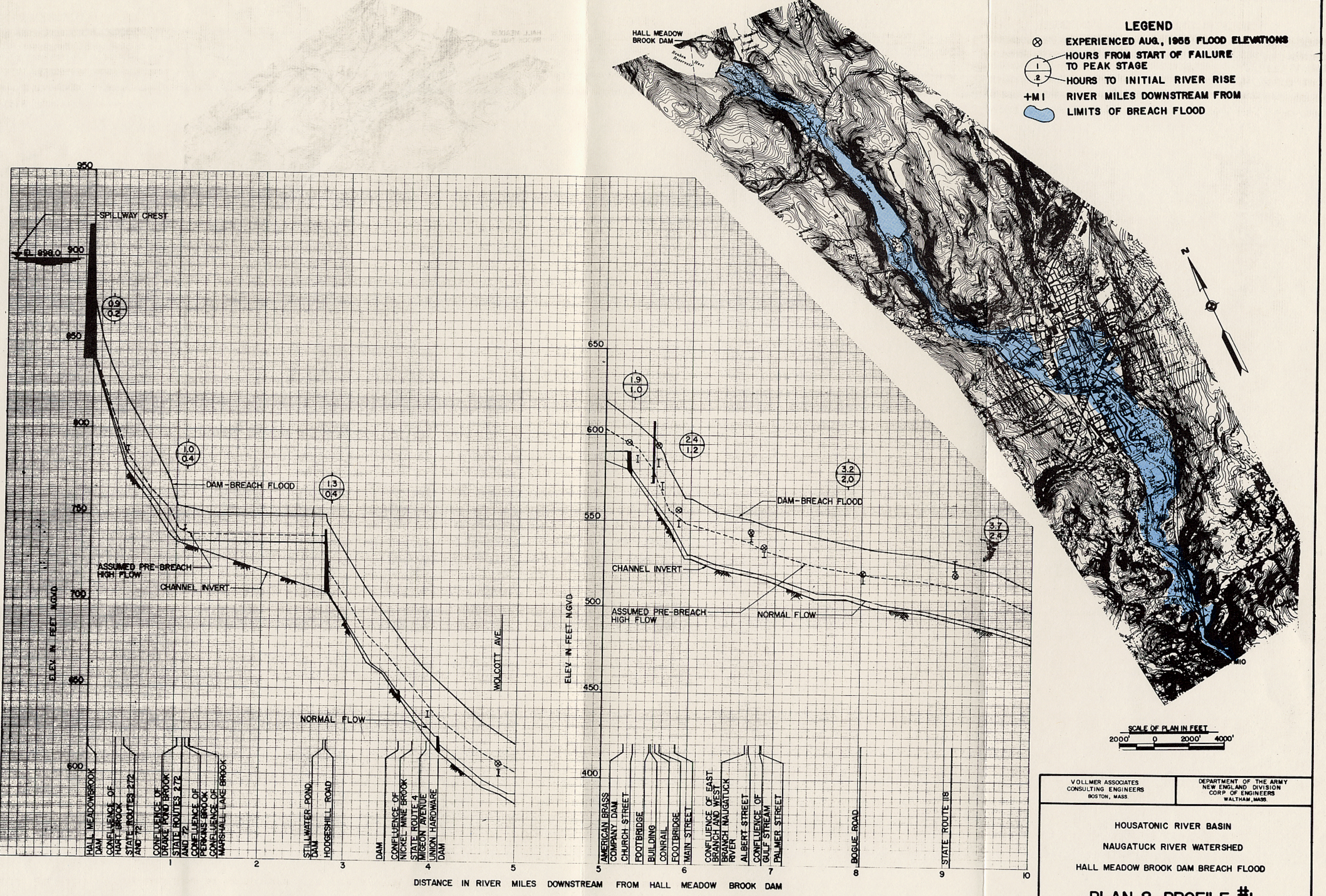

CORPS OF ENGINEERS
U. S. ARMY
UPSTREAM
TYPICAL ROCK TOE DETAIL - UPSTREAM
SCALE 1" = 5'
TYPICAL ROCK TOE - DOWNSTREAM
STA. 1+50
STA. 11+50
STA. 3+00
STA. 5+00
STA. 8+65
STA. 9+25
TOP OF DAM DETAIL
UPSTREAM
DOWNSTREAM
Compacted Impervious Fill
Compacted Random Fill
Rock Fill
Gravel Filter
Gravel Bedding
Original Ground Surface
Stripping Line
Assumed Bedrock Surface
Foundation Cut-off
Strip to rock
Hall Meadow Brook Channel
NOTES:
Elevations refer to Mean Sea Level Datum.
Figures in hexagons indicate item numbers under which payment will be made.
For Dam Plan and Profile, see sheet No. 4
Record Drawing
HOUSATONIC RIVER FLOOD CONTROL
HALL MEADOW BROOK DAM
DAM EMBANKMENT
SECTIONS
CONNECTICUT
OCT. 1960
HC-1-1605

PLATE 4



VOLLMER ASSOCIATES
CONSULTING ENGINEERS
BOSTON, MASS.

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORP OF ENGINEERS
WALTHAM, MASS.

HOUSATONIC RIVER BASIN

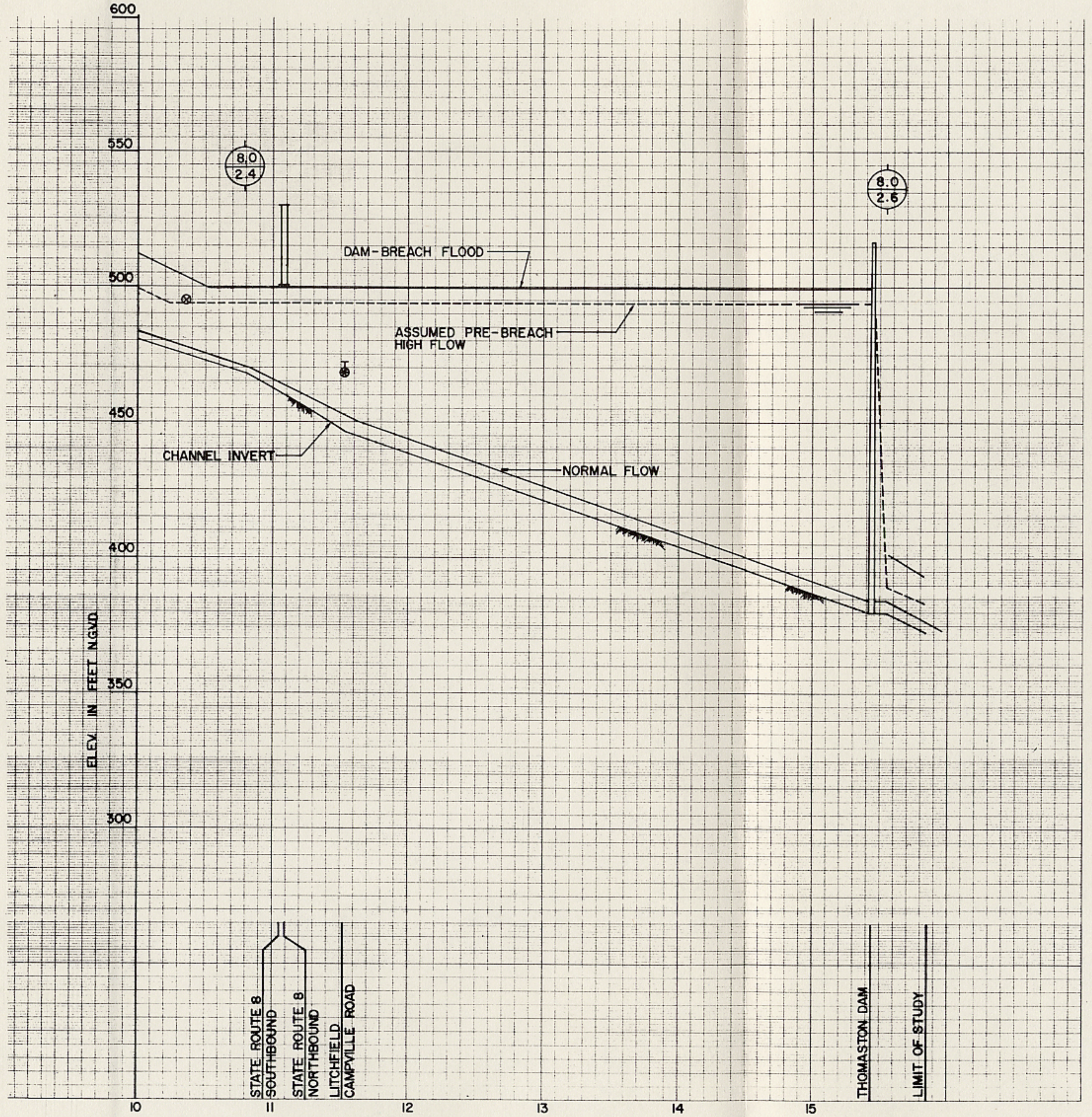
NAUGATUCK RIVER WATERSHED

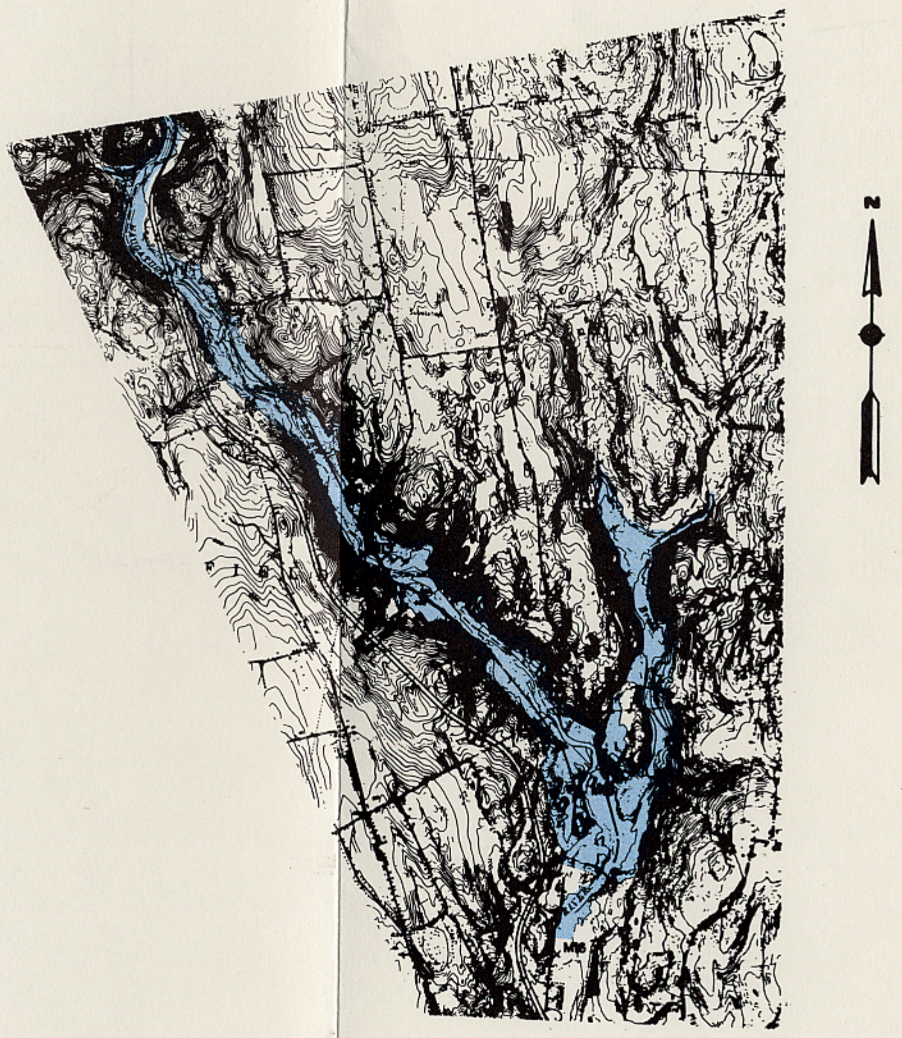
HALL MEADOW BROOK DAM BREACH FLOOD

PLAN & PROFILE #1

LEGEND

- ⊗ EXPERIENCED AUG., 1955 FLOOD ELEVATIONS
- (1 over 2) HOURS FROM START OF FAILURE TO PEAK STAGE / HOURS TO INITIAL RIVER RISE
- +MI RIVER MILES DOWNSTREAM FROM
- LIMITS OF BREACH FLOOD





SCALE OF PLAN IN FEET
2000' 0 2000' 4000'

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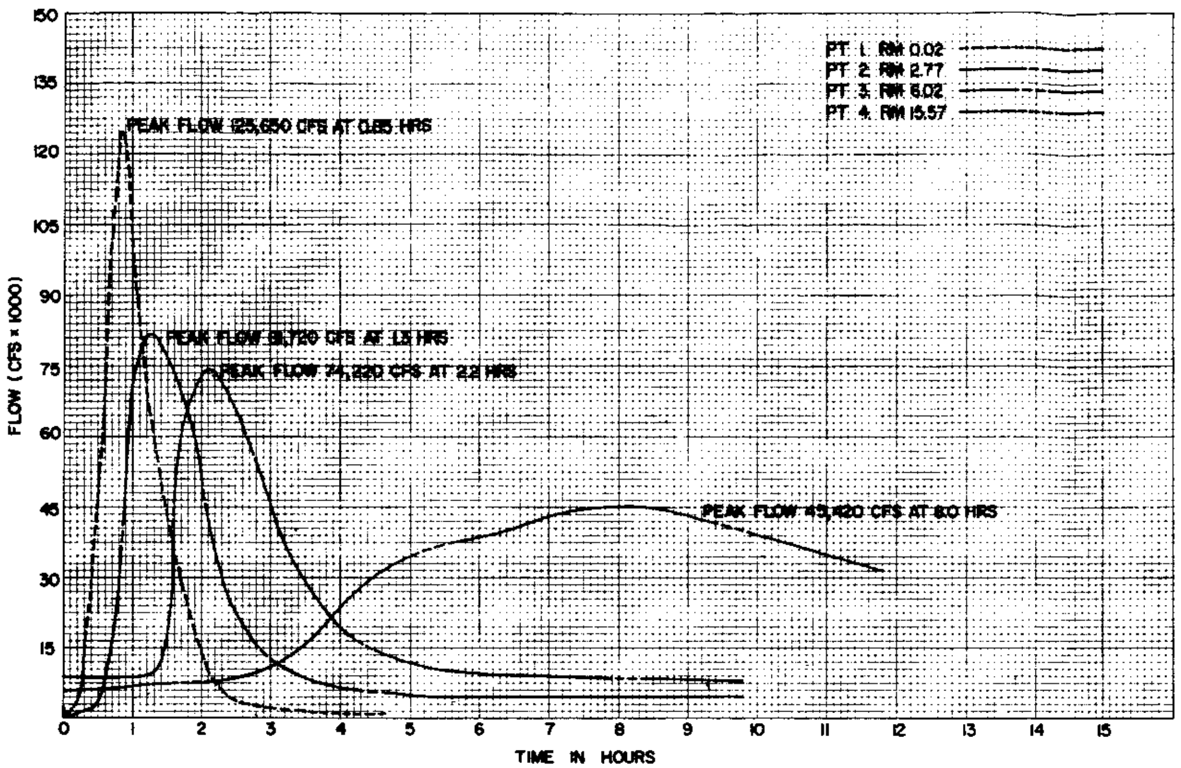
HOUSATONIC RIVER BASIN

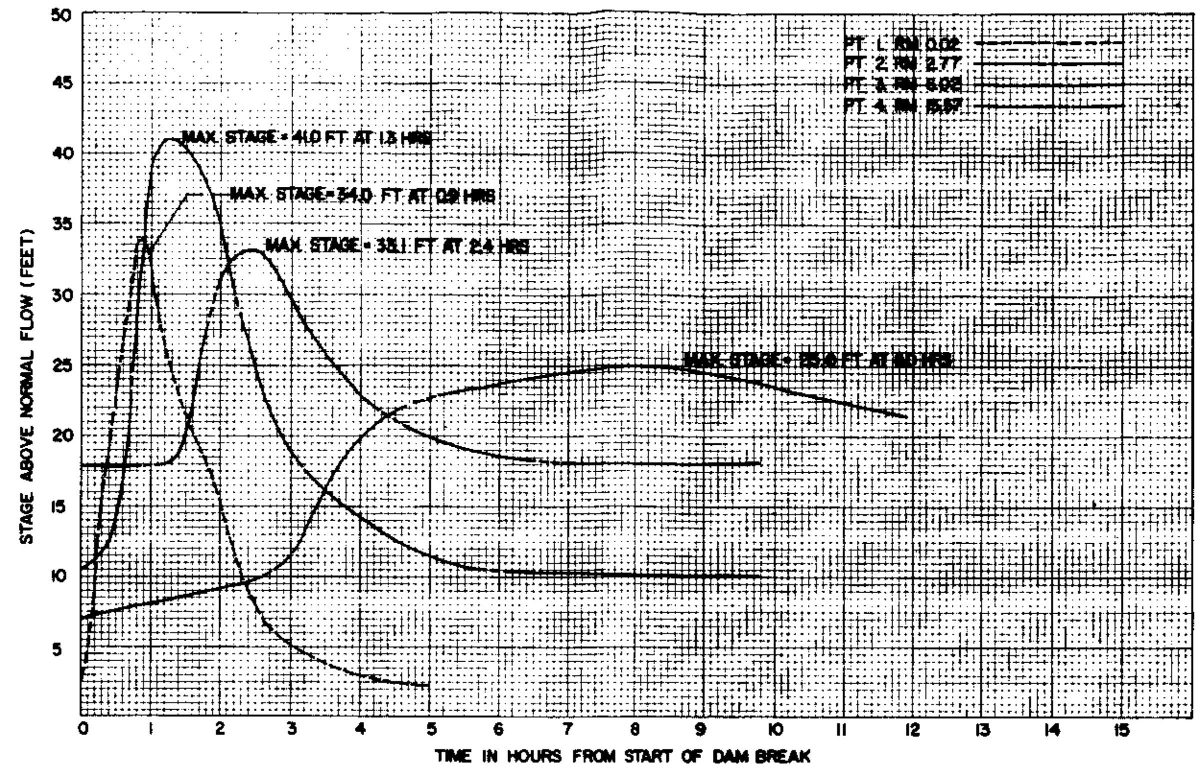
NAUGATUCK RIVER WATERSHED

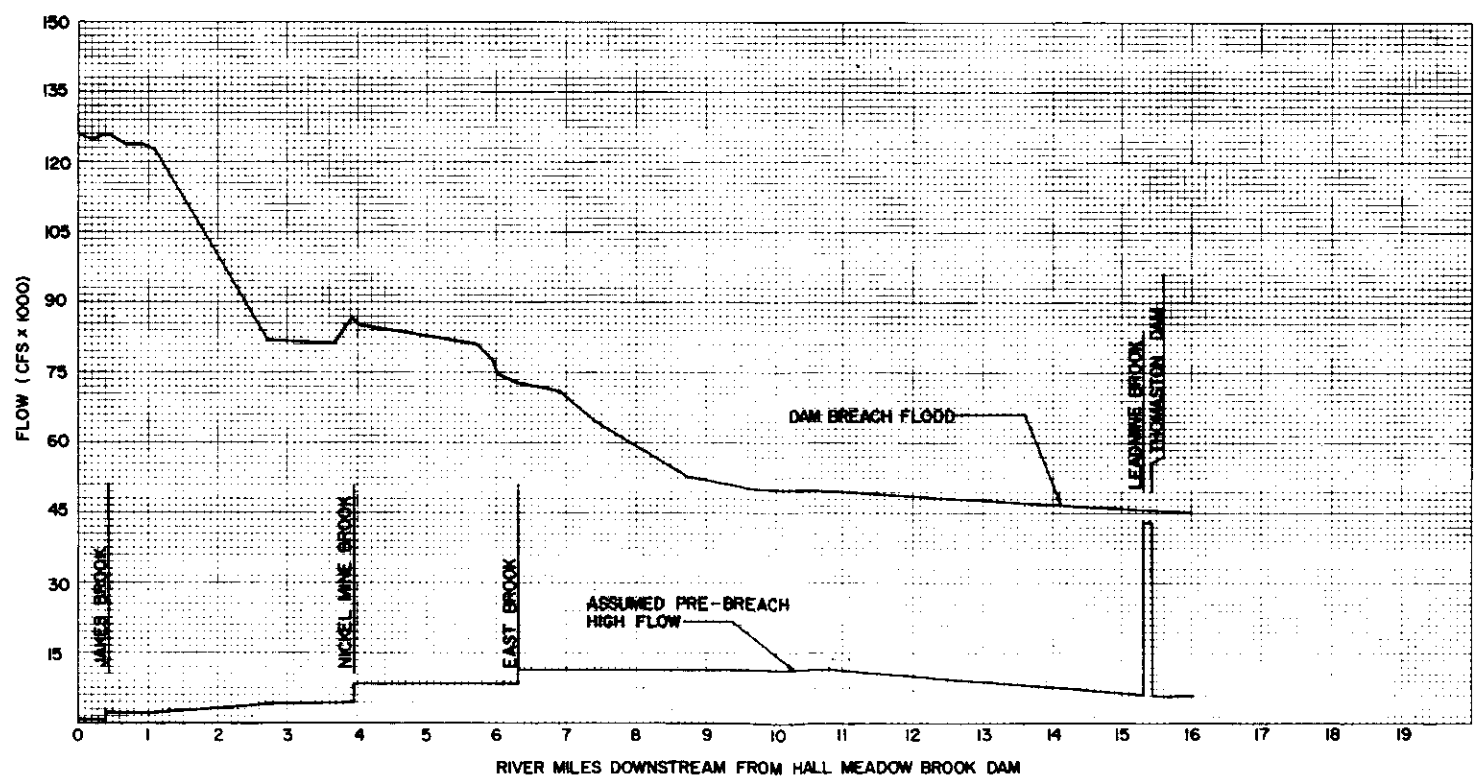
HALL MEADOW BROOK DAM BREACH FLOOD

PLAN & PROFILE #2

PLATE 6







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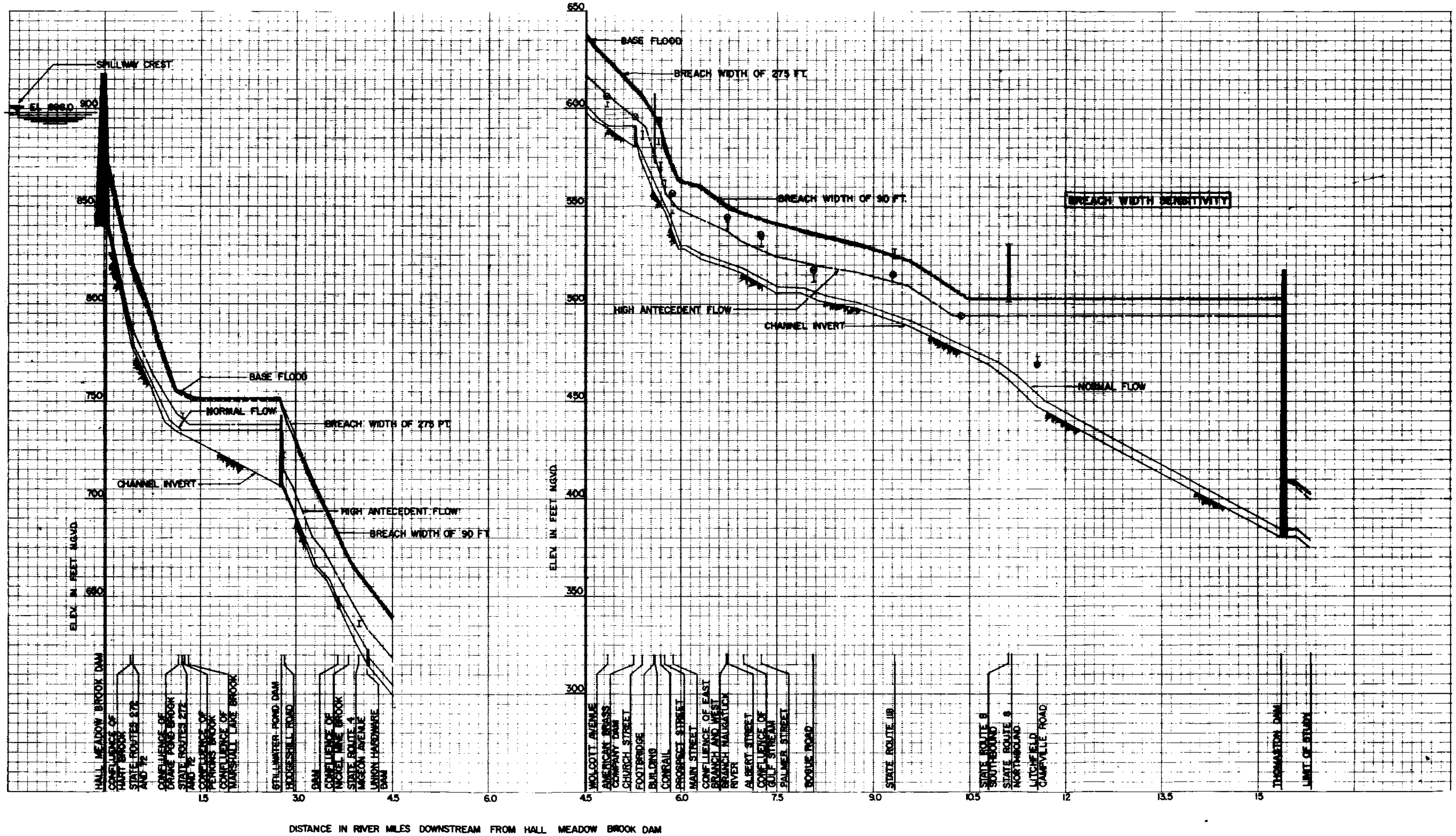
HOUSATONIC RIVER BASIN

NAUGATUCK RIVER WATERSHED

HALL MEADOW BROOK DAM BREACH FLOOD

BASE FLOOD DISCHARGES STAGES & TIMING



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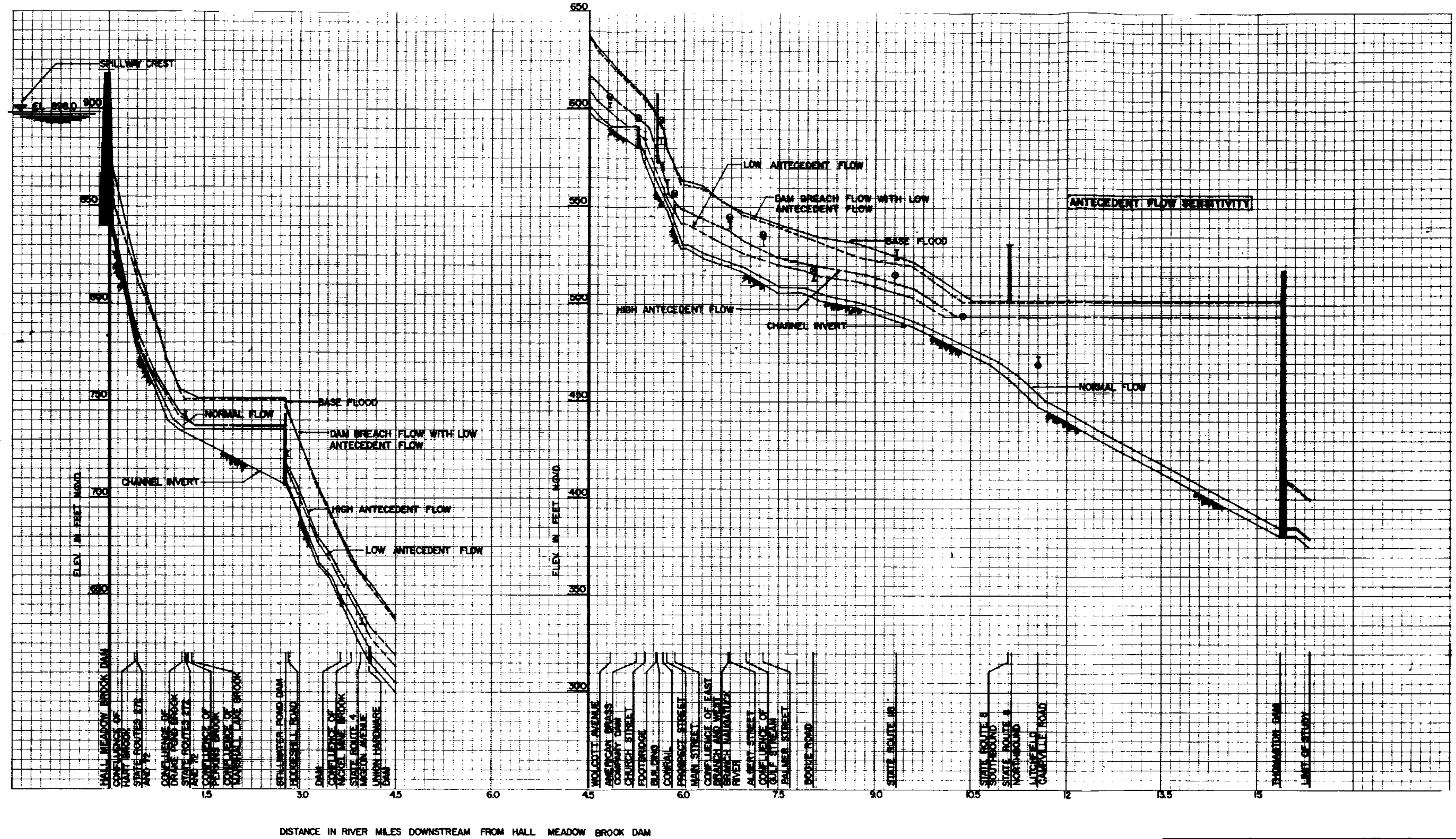
HOUSATONIC RIVER BASIN

NAUGATUCK RIVER WATERSHED

HALL MEADOW BROOK DAM BREACH FLOOD

SENSITIVITY OF INPUT

PLATE 8



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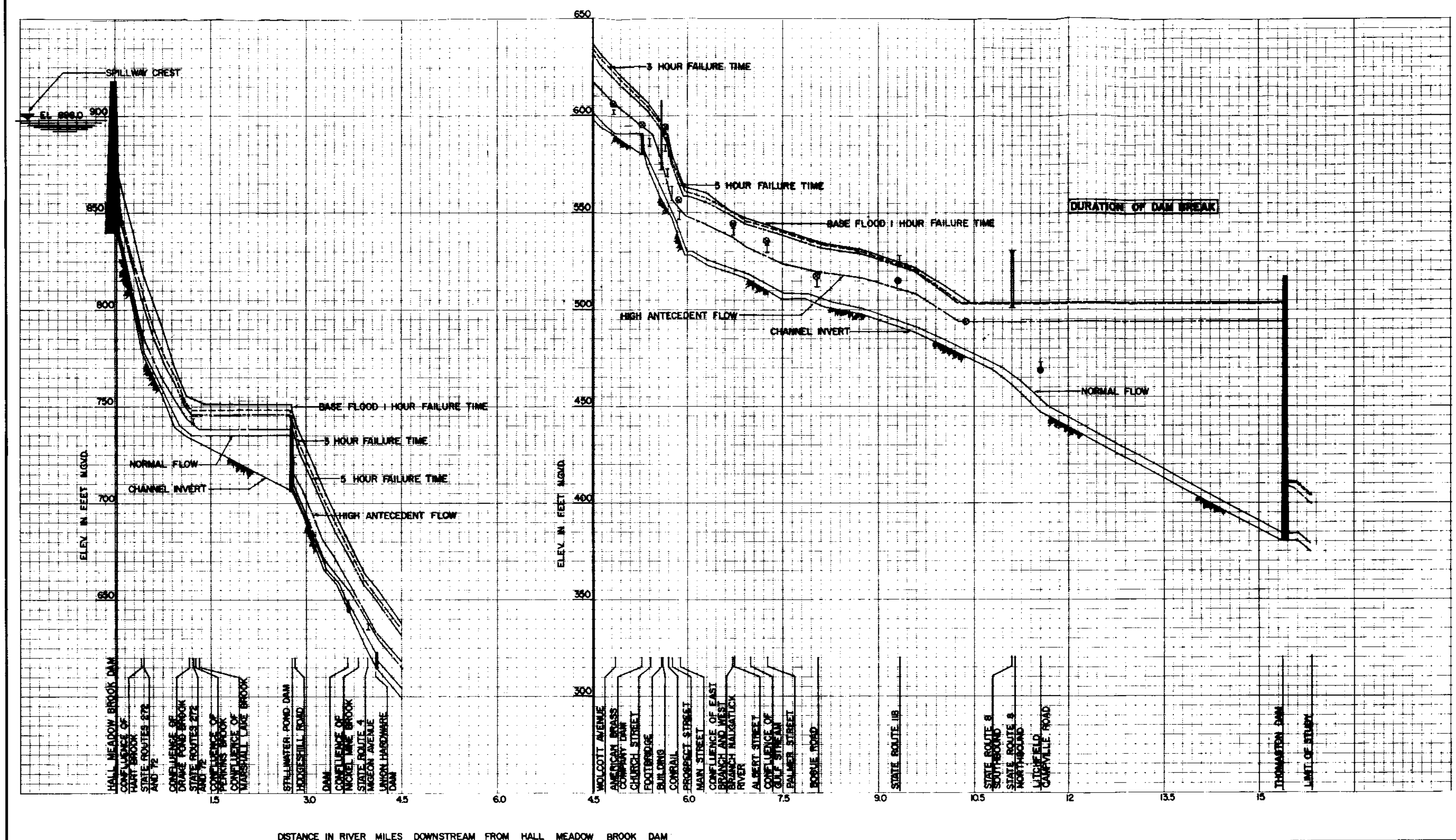
HOUSATONIC RIVER BASIN

NAUGATUCK RIVER WATERSHED

HALL MEADOW BROOK DAM BREACH FLOOD

SENSITIVITY OF INPUT



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WALTHAM, MASS.

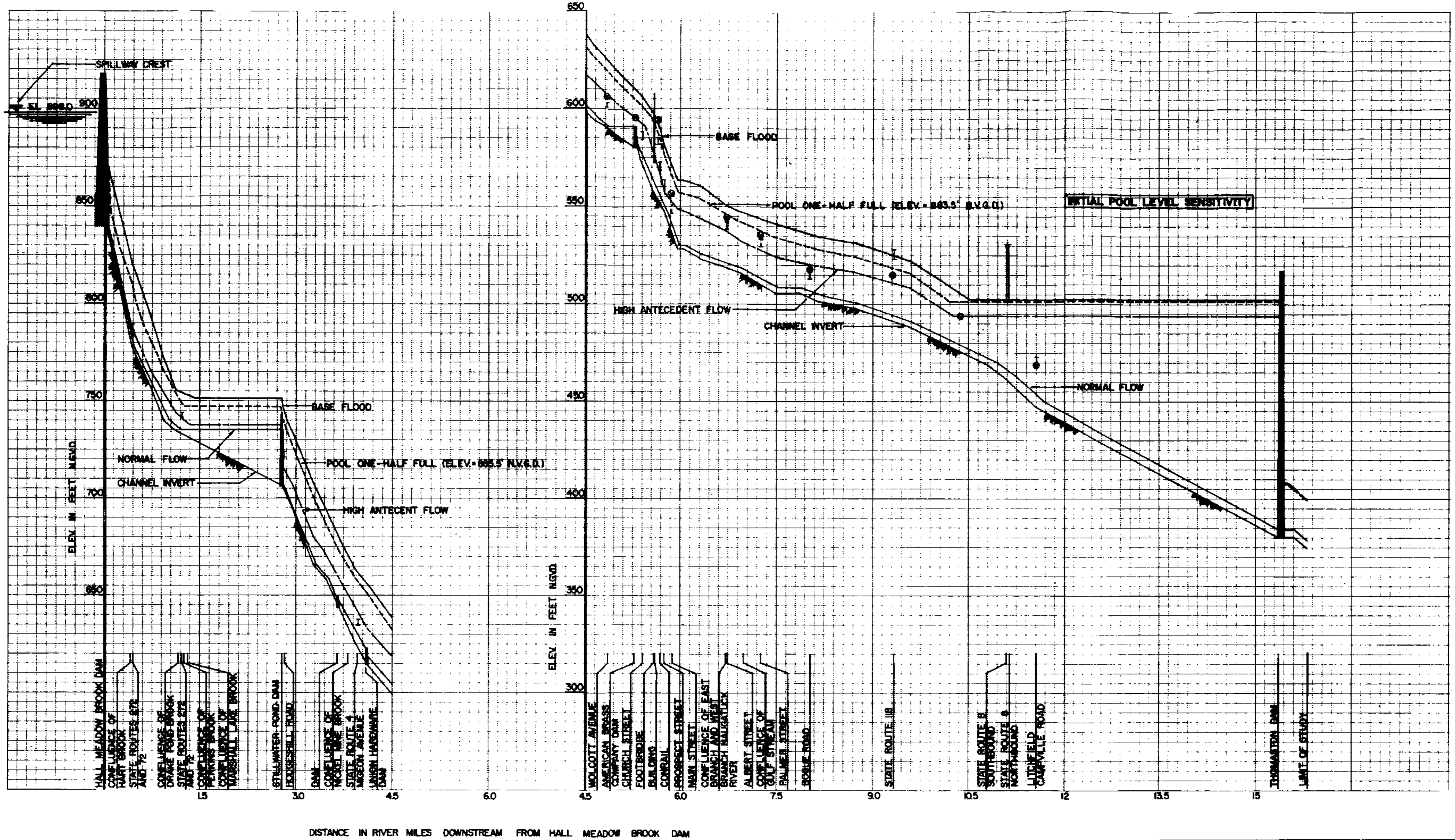
HOUSATONIC RIVER BASIN

NAUGATUCK RIVER WATERSHED

HALL MEADOW BROOK DAM BREACH FLOOD

SENSITIVITY OF INPUT

PLATE 10



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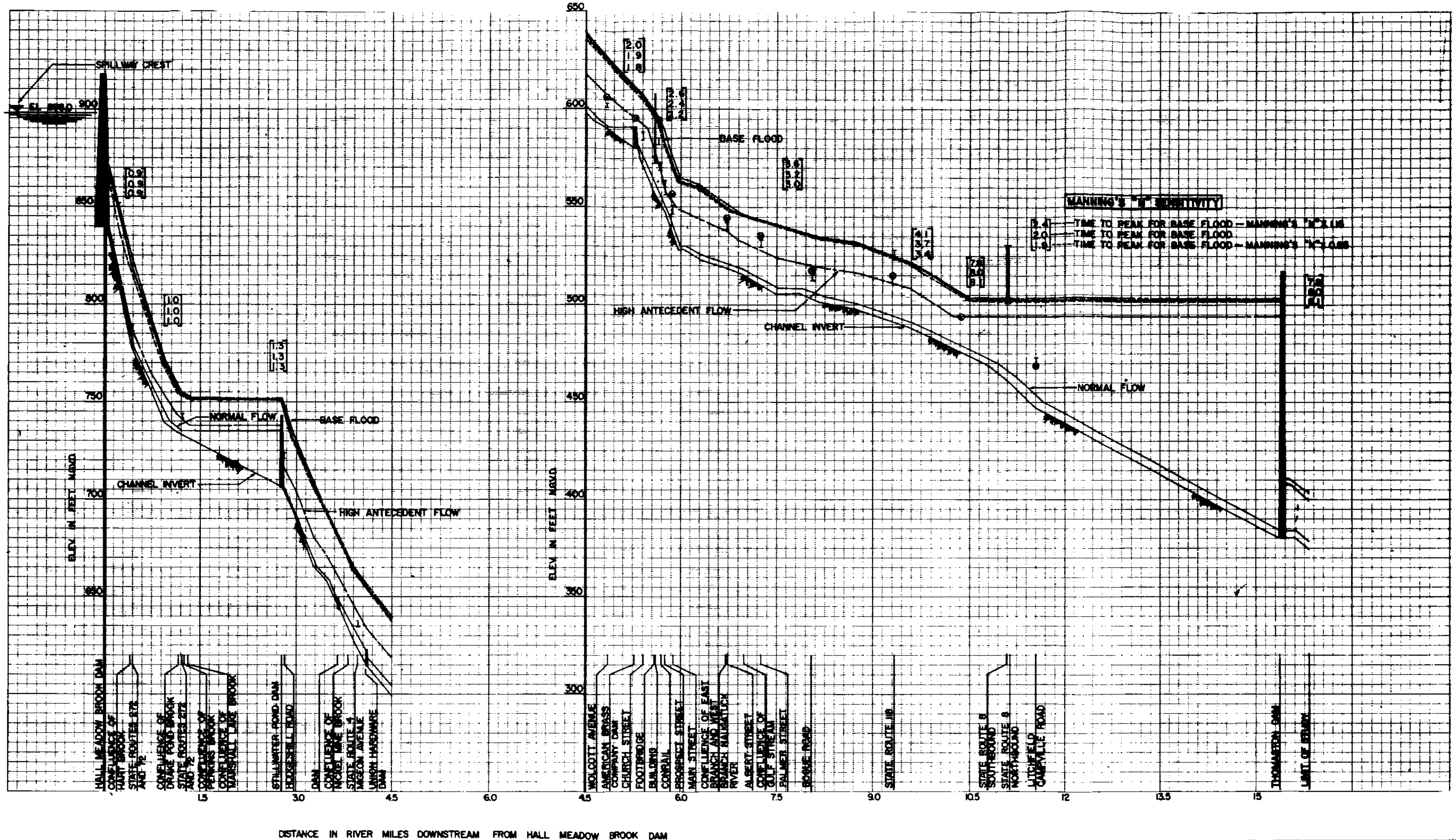
NAUGATUCK RIVER WATERSHED

HALL MEADOW BROOK DAM BREACH FLOOD

SENSITIVITY OF INPUT



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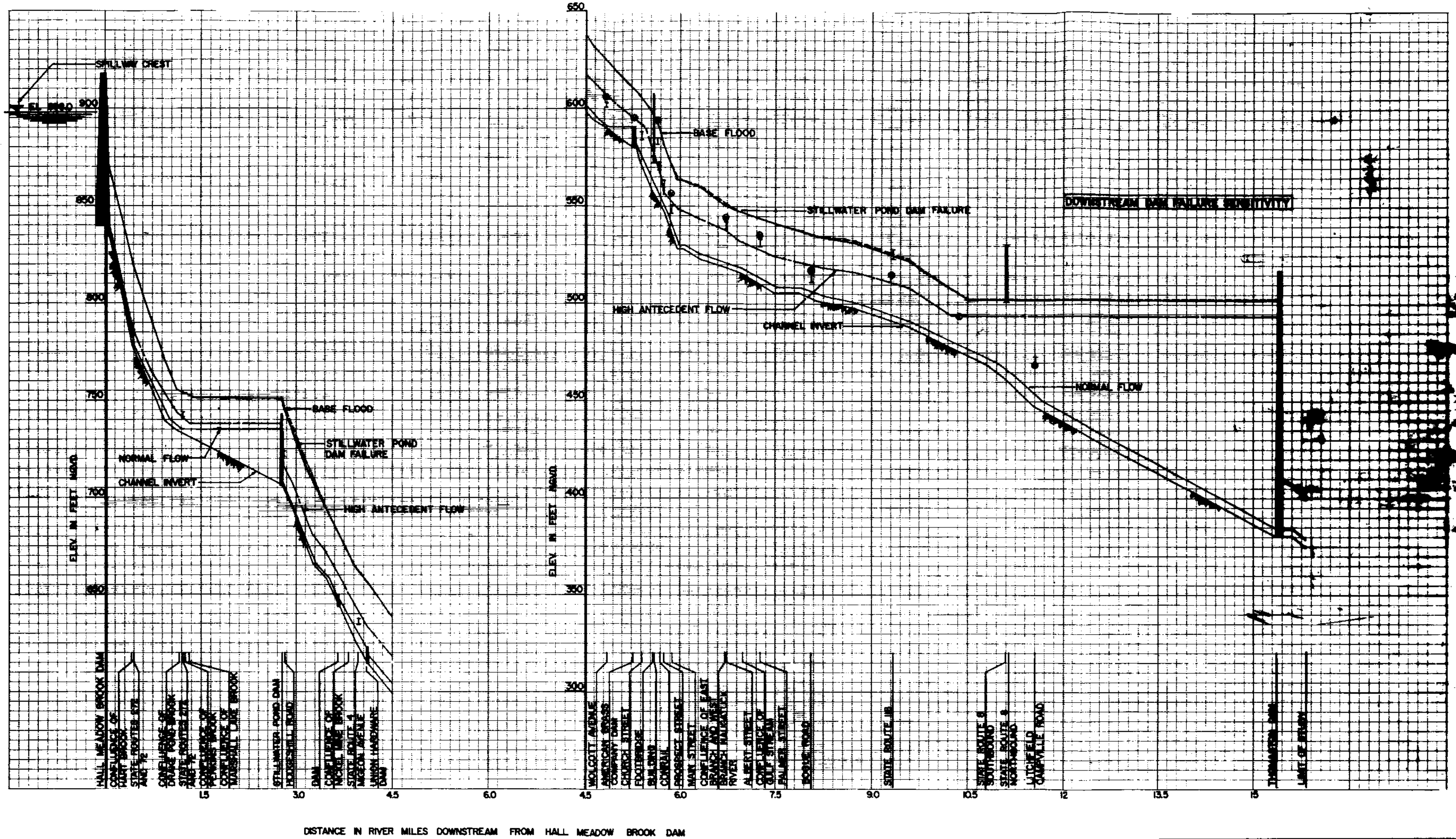
HOUSATONIC RIVER BASIN

NAUGATUCK RIVER WATERSHED

HALL MEADOW BROOK DAM BREACH FLOOD

SENSITIVITY OF INPUT

PLATE 12



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WALTHAM, MASS.

HOUSATONIC RIVER BASIN

NAUGATUCK RIVER WATERSHED

HALL MEADOW BROOK DAM BREACH FLOOD

SENSITIVITY OF INPUT

PLATE 13

HALL MEADOW BRK DAM HALL MEADOW BROOK   VOLLMER ASSOCIATES
BOSTON, MA 02116   APRIL 3, 1986   #081

1	0	0	0	11	0	0	0
8620	6023	3509	1569	802	318	106	0
898	890	880	870	865	860	855	842
2.46	898.0	1	840	175	1.0	842	1
898.0	917.0	898.0	0	0	0	0	800
0	1000	1750	2600	5200	8000	11300	18800
0	2	3	4	6	8	10	14
1	10						
800	800	800	800	800	800	800	800
800	800	800					
6	8	4	4	0	0	1	
1	2	4	6				
0.02							
840.0	843	849	849.1	850	860	870	880
42	55	110	160	165	295	500	895
0.23							
805.6	810	820	830	840	850	860	870
0	20	300	600	1110	1280	1440	1590
0.40							
777.8	780	790	800	810	820	830	840
0	20	100	350	560	735	900	1040
0.70							
757.0	760	770	780	790	800	810	820
0	20	320	410	575	695	715	790
0.92							
739.2	750	760	770	780	790	800	810
0	20	600	780	905	1075	1200	1460
1.11							
734.7	740	750	760	770	780	790	800
0	20	1175	1520	1740	2100	2200	2310
0.070	0.100	0.120	0.140	0.140	0.140	0.150	0.160
0.070	0.090	0.100	0.120	0.140	0.140	0.150	0.160
0.070	0.085	0.090	0.200	0.140	0.140	0.150	0.160
0.065	0.075	0.085	0.100	0.140	0.140	0.150	0.160
0.060	0.075	0.085	0.100	0.140	0.140	0.150	0.160
0.10	0.10	0.10	0.10	0.10	0.10		
0	0	0	0	0	0		
0	0	0.00	0.00	96	0	0	0
2							
1650	1650	1650	1650	1650	1650	1650	1650
1650	1650	1650					

STILLWATER POND DAM W. BRANCH NAUGATUCK VOLLMER ASSOCIATES
BOSTON, MA 02116 APRIL 4,1986 #DB1

1	1	1	0	18	0	0	0
1							
5678	3630	2050	1100	0			
760	750	743	735.0	708			
1.57	738.2	0	708	105	0.5	708	1
1000.0	743	735.0	0	0	0	0	500
0	1900	3500	7600	13200	28800	96510	241000
0	2	3	5	7	10	17	25
0.0	10						
4606	8784	21510	64368	118097	124739	112184	78677
42419	14398	8784	6828	5396	4907	4663	4623
4611	4500						
0	0.4	0.5	0.7	0.9	0.95	1.1	1.3
1.7	2.3	2.6	2.9	3.5	4.0	4.5	4.6
4.7	10.0						
24	8	.6	4	0	0	2	
1	2	10	15	20	23		
0.01							
706.4	706.9	709	721	721.1	735	750	760
0	19.5	67	130	150.5	500	850	1100
0.02							
706.2	706.9	709	721	721.1	734	750	760
0	19.5	67	130	150.5	232	500	900
0.18							
694	695	697.2	703	705.4	706.3	750	760
0	42	47	83	115	143	700	1050
0.49							
666	668.4	669	687.5	687.6	690	700	720
0	13	39	148	162	180	548	800
0.70							
658.2	659.3	660	666.3	670.7	680	700	710
0	32	38	76	148	448	700	720
0.92							
643	643.6	652.7	652.8	660	670	680	695
20	60	103	115	235	390	470	659
1.16							
625.6	627	630	641	650	660	670	680
0	12	24	185	590	800	1050	1200
1.34							
614.4	627	628.6	630.2	640	650	660	665
70	70	128.5	161	161	1050	1200	1238
1.86							
594.0	594.1	607.7	610.2	614	620	630	640.0

0	43	127	310	390	700	1275	1540
2.61							
573.1	573.2	575.3	583.5	588.5	590	600	610
0	39	53	84.5	154	350	1350	1900
2.80							
558.3	562.1	563.5	564.1	577.5	580	590	600
32	32	49	58	67	135	625	3750
2.93							
550.6	553.6	559.8	560.4	572.8	580	590	600
26	58.6	58.6	66	66	690	1850	2400
3.00							
546.2	550	560	564	570	580	590	600
80	80	80	80	310	910	4340	4970
3.19							
528	535	542	542.1	550	560	570	580
84	113.5	143.5	149	2050	3825	4700	6000
3.27							
527.9	537	542	542.1	550	560	570	580
86	125	135	155	1800	2500	5140	5210
3.55							
522.8	530	536.9	540	550	560	570	580
120	147	171.5	650	750	830	2490	4300
3.95							
518.5	519	533.5	533.6	540	550	560	570
0	129	186.5	196.5	650	730	1100	3500
4.16							
516	519	532	532.1	540	550	560	570
130	196	251	297	1565	1660	3270	3750
4.72							
505.1	508.5	510	520	530	540	550	555
60	120	250	575	650	2400	2475	3200
5.08							
505.0	509.5	510	520	530	540	550	555
50	100	150	550	650	1850	2200	2362
5.38							
501.1	505.1	510	520	530	540	550	555
50	100	450	565	1175	1280	1450	1525
5.97							
497.5	499.5	500	510	520	530	540	550
50	100	150	520	800	1090	1125	1210

6.82							
487.8	490.8	500	510	520	530	540	550
40	80	130	410	450	510	575	620
8.04							
468.1	470	475	480	490	500	510	520
50	100	280	475	575	625	775	875
0.060	0.080	0.110	0.120	0.140	0.140	0.150	0.160
0.055	0.075	0.095	0.120	0.140	0.140	0.150	0.160
0.050	0.070	0.090	0.120	0.140	0.140	0.150	0.160
0.050	0.070	0.090	0.120	0.140	0.140	0.150	0.160
0.050	0.070	0.090	0.120	0.140	0.140	0.150	0.160
0.050	0.070	0.090	0.120	0.140	0.140	0.150	0.160
0.050	0.070	0.100	0.120	0.140	0.140	0.150	0.160
0.050	0.070	0.110	0.120	0.140	0.140	0.150	0.160
0.055	0.070	0.110	0.120	0.140	0.140	0.150	0.160
0.055	0.070	0.110	0.120	0.140	0.140	0.150	0.160
0.050	0.070	0.110	0.120	0.140	0.140	0.150	0.160
0.050	0.070	0.110	0.120	0.140	0.140	0.150	0.160
0.055	0.075	0.110	0.120	0.140	0.140	0.150	0.160
0.060	0.080	0.110	0.120	0.140	0.140	0.150	0.160
0.060	0.080	0.110	0.120	0.140	0.140	0.150	0.160
0.055	0.075	0.110	0.120	0.140	0.140	0.150	0.160
0.050	0.075	0.110	0.120	0.140	0.140	0.150	0.160
0.050	0.070	0.110	0.120	0.140	0.140	0.150	0.160
0.050	0.070	0.100	0.120	0.140	0.140	0.150	0.160
0.050	0.070	0.100	0.120	0.140	0.140	0.150	0.160
0.045	0.065	0.100	0.120	0.140	0.140	0.150	0.160
0.045	0.065	0.100	0.120	0.140	0.140	0.150	0.160
0.045	0.065	0.100	0.120	0.140	0.140	0.150	0.160
0.005	0.02	0.05	0.05	0.05	0.05	0.05	0.05
0.05	0.05	0.05	0.05	0.05	0.10	0.10	0.10
0.10	0.10	0.10	0.10	0.10	0.10	0.10	
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	
0	0	0.00	0.0	65	0	0	0
6	15						
4130	4130	4130	4130	4130	4130	4130	4130
4130	4130	4130	4130	4130	4130	4130	4130
4130	4130						
3100	3100	3100	3100	3100	3100	3100	3100
3100	3100	3100	3100	3100	3100	3100	3100
3100	3100						

THOMASTON DAM   NAUGATUCK RIVER   VOLLMER ASSOCIATES
BOSTON, MA 02116   APRIL 7, 1986   #DB1

1	0	0	0	19	0	0	0
42000	22606	11666	7746	4818	2739	1276	0
494	470	450	440	430	420	410	380
4.75	494.0	1	380	410	1.0	380	1
2000.0	517.0	494.0	0	0	0	0	5800
0	3200	11100	22600	36000	51500		
0	2	4	6	8	10		
0.0	12.0						
13710	14830	17699	22968	30808	47193	52098	54483
54852	55026	54242	50832	44691	44126	51646	45058
36800	30951	21940					
0	1.6	2.4	2.6	2.8	3.2	3.4	3.6
3.663	3.8	4.0	4.4	5.0	6.0	7.0	8.0
9.0	10.0	12.0					
2	8	2	4	0	0	0	
1	2						
0.06							
380	385	390	400	400.1	410	425	430
136	170	204	350	699	874	1359	1447
0.39							
370.5	374	380	390	400	410	430	450
23	50	238	400	520	820	1155	1280
0.080	0.095	0.120	0.140	0.140	0.140	0.150	0.160
0.05							
0							
0	0	0.00	0.00	29	0	0	0